PATENT SPECIFICATION

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DRAWINGS ATTACHED

1 252 984

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(54) IMPROVEMENTS IN STABLE ELECTRICALLY IGNITABLE SOLID LOW EXPLOSIVE CHARGES

(71) We, USM CORPORATION, of Flemington, New Jersey, United States of America, a corporation duly organized under the laws of said State of New Jersey, having a place of business at 140 Federal Street, Boston, Commonwealth of Massachusetts, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention is concerned with improvements in or relating to stable electrically ignitable solid low explosive charges, and especially, but not exclusively, to low explosive charges intended for use in explosively actuated stud driving tools or the like.

Reliable explosive charges arranged to be ignited by impact are commercially available, but they usually require that mechanical or potential firing energy, perhaps of the order of 0.6—2 joules, be provided as by manually cocking a spring for acting on a firing pin. In many situations a workman prefers to avoid such inconvenience and desires, especially where repeat fire is practised or environment is adverse, more easily and quickly to attain ignition by merely actuating a switch to energize a circuit capable of initiating deflagration and consequent detonation of a propellant charge. Electro-explosives hitherto known have, so far as we are aware, incorporated sensitive, high explosive and various more or less complicated hot wire ignition means.

It is an object of the present invention to provide an improved low explosive charge incorporating electrical ignition means.

The invention provides an electrically ignitable solid low explosive charge comprising fibrous nitrocellulose compacted to a density of not greater than 1.6 gms. per c.c. to provide a pellet having substantially interconnected interstitial air spaces between its fibres to form continuous burning surfaces, and an electric conductor extending through the pellet between opposite surfaces thereof for effecting its ignition by resistance heating, said conductor being of a material and dimensions selected to leave substantially no residue upon explosion of the charge.

A charge as set out in the last preceding paragraph is preferably cylindrical with substantially planar opposite surfaces, but may be of other configuration, e.g. recessed if desired. A fibre density of the pellet of about 0.9 gms. per c.c. is preferred for peak efficiency.

There now follows a detailed description, to be read with reference to the accompanying drawing, of a solid low explosive charge illustrative of the invention, and of modified forms of it. It will be realised that this illustrative charge and its modified forms have been selected for description by way of example and not by way of limitation of the invention.

In the accompanying drawing:—

Figure 1 is a perspective view of the illustrative charge having a sector removed to reveal a central, axial igniting conductor, of graphite for instance;

Figure 2 is a perspective view of one-half of a modified form of the illustrative charge shown with a wire conductor, terminal end portions of the conductor being radially disposed and embedded in opposed faces of the charge;

Figure 3 is a view corresponding to Figure 2 but showing a conductive wire with at least partly circular terminal end portions abutting opposed faces of the charge; and

Figure 4 is an enlarged detail view depicting interconnected, interstitial air spaces providing continuous burning surfaces on flat, ribbon-like nitrocellulose fibres employed in the charges of Figures 1—3, and showing a portion of the conductor.

Figure 1 shows the illustrative charge 10 which comprises a cylindrical pellet of compacted nitrocellulose fibres 12 having a density in the range of from 0.6 to 1.6 gms/c.c. The pellet of the illustrative charge is made

by a procedure as described in the complete specification of our copending Patent Application No. 4555/67 (Serial No. 1,171,338). Axially extending between opposed planar end faces of the pellet 10 is an electric, heat generating conductor in the form of a slender rod of graphite 14. It will be apparent that the illustrative charge 10 as shown in Figure 1, as well as in its modified forms as shown in Figures 2 and 3, may be compacted to a self-sustaining form which is non-circular in section if desired, the disc-like shape usually being preferred to enable substantially closed sealing of a cylindrical firing chamber which is to receive it. For effecting electrical ignition of the charge 10 the current conductor 14 has its opposite end, while the charge is confined in a substantially closed chamber, contacted by electrodes of a circuit (not shown) connected to a suitable source of electric energy, for example a suitable battery or a capacitor discharge.

The illustrative charge as shown in Figure 1 may be made in quantity from an elongated cylindrical form, an entire length of graphite being axially disposed in the fibres of nitrocellulose as they are compacted from a slurry. Numerous individual charges 10 of the desired degree of power (corresponding approximately to their selected individual axial lengths) may then be transversely severed from the full length prior to final drying and hardening, as by a jet of cutting fluid, for example water.

The pellets 16 (Figure 2) and 18 (Figure 3) of the illustrative charge in its modified forms have their main body portions of compacted fibrous nitrocellulose in the manner of the charge 10. In the pellet 16, a bridge wire 20 may, for example, be of "NICHROME" (75% Ni, 12% Fe, 11% Cr, 2% Mn) or stainless steel having a diameter of about .003"; "NICHROME" is a Registered Trade Mark. The wire need not be of a single strand but its melting point is preferably above that of copper, which is 1082°C. Its radial terminal portions 22, 22 (or at least one of them) are preferably lying exposed but partly embedded in opposite flat faces, respectively. These portions are accordingly protected to some extent from being broken off, but are readily contactable by suitable electrodes of an ignition circuit. An intermediate portion 24 of the wire 20 preferably extends axially through a central portion of the pellet 16 and may be somewhat bowed as a consequence of angularly deflecting the terminal portions at the time of wire insertion, or as a result of pellet compaction.

The illustrative charge of Figure 3 has a bridge wire 26 like that shown in Figure 2 except that its terminal portions 28, 28 have a generally circular configuration to provide more exposed surface for contact with an electrode. The portions 28 need not be partly embedded but preferably should not extend appreciably from the exterior of the charge since this might result in its damage or a premature firing due to an earlier than intended electrical contact with a firing circuit.

It will be apparent from Figure 4, wherein the conductor may be of any of the types above mentioned or other conductive, consumable material, that the lengthy, ribbon-like fibres of nitrocellulose (shown much enlarged) have numerous engagements or near-engagements with the conductor. Accordingly, experience indicates a very reliable and prompt ignition is assured once a firing circuit has been energised.

The following table shows, for three different sources of electric energy, the amount of energy required to effect explosion, and the delay in firing following closure of the firing circuit, for different combinations of nitrocellulose pellets and their particular electric conductors. Energy requirements for effecting explosion of compacted nitrocellulose by electrical heating in certain of the sample charges indicated are advantageously lower than what is usually required by percussion ignition. It may be mentioned that when it is desired to preclude accidental firing by spurious electric currents, for instance to meet the so called "one watt of power and one ampere of current, 5 minute exposure but no fire" test, the thickness or diameter of the heating element may be enlarged and/or the density of the nitrocellulose surrounding the element increased to the 1.3 to 1.6 gms./c.c. range. For reduced delay, as is desirable in the usual firearm or construction tool, it is found especially desirable that there be, between the heating element and the main pellet body (having a density not greater than 1.6 gms./c.c.), a relatively "fluffy" portion of nitrocellulose fibres having a reduced density, perhaps on the order of about half that of the main body. In the table, the portion of lower density nitrocellulose is referred to as "fluffy", its actual density not being easily ascertainable. This portion presumably facilitates ignition by reason of its having more or larger open air spaces contiguous with the heating element and between the ribbon-like fibres, a condition not illustrated in Figure 4.

Nitrocellulose Pellet (fibre density, gms/millilitre)	*Heating Element*	*Delay* (milli-seconds)	*Energy* (joules)
	6 V DC Storage Battery		
1.54 body; fluffy around wire	.003″ diam. copper wire	2.6	0.263
1.54 body; fluffy around wire	.006″ diam. copper wire	8	0.270
1.55	.047″ diam. pencil lead	180	6.16
1.55	.047″ diam. pencil lead	140	8.50
1.60	.047″ diam. pencil lead	92	8.15
1.5 or more	Tungsten wire from fluorescent lamp	4	.097
1.5	.001″ Ni-Cr wire	17	.025
0.97	.036″ diam. pencil lead	50	5.4
0.97	.047″ diam. pencil lead	95	6.18
0.95	.020″ pencil lead	45	1.25
0.95	.003″ Ni-Cr wire	12.1	0.104
1.2	.003″ Ni-Cr wire	13	.986
1.49	.003″ Ni-Cr wire	5	.092
	Cadmium Cell 1.35 V		
1.54 body; fluffy around wire	.006″ diam. copper wire	22	0.915
1.54 body; fluffy around wire	.003″ diam. copper wire	12	0.177
1.2 body	two .003″ Ni-Cr wires twisted together	190	1.82
	Capacitor Discharge (500 Microfarads 60v)		
1.54 body	.003″ diam. copper wire	3	0.294
0.95 body	.003″ Ni-Cr wire	5	0.025

It will be understood that the representative charges selected for the table shown were disc-shaped, had substantially constant thickness of about 0.1″ and an outside diameter of about .336″. They were usually "custom made" in the sense that they initially were provided with a 3/32″ bore for receiving the heating element and the main body of the pellet was thereafter compressed by a hollow die gradually to compact the fibres to cause them to close on the element; where the element-contacting fibres were to remain "fluffy" only a light tamping was given. In each case, the heating element is of such material and dimensions that on explosion of the charge it leaves substantially no residue.

The illustrative charge, in any of the forms

an electrical initiation, and affords satisfactory performance with adequate safety at low cost.

WHAT WE CLAIM IS:—

1. An electrically ignitable solid low explosive charge comprising fibrous nitrocellulose compacted to a density of not greater than 1.6 gms. per c.c. to provide a pellet having substantially interconnected interstitial air spaces between its fibres to form continuous burning surfaces, and an electric conductor extending through the pellet between opposite surfaces thereof for effecting its ignition by resistance heating, said conductor being of a material and dimensions selected to leave substantially no residue upon explosion of the charge.

2. A charge according to claim 1 in which the conductor is a centrally extending cylindrical rod of graphite.

3. A charge according to claim 2 which is in the form of a disc having its opposite surfaces substantially planar.

4. A charge according to claim 1 in which the conductor is a metal wire the terminal portions of which are exposed to provide contact ignition terminals on the opposite surfaces of the pellet, the melting point of the wire being higher than 1082°C.

5. A charge according to claim 4 in which said terminal portions of the wire extend radially and are partly embedded in opposite surfaces of the pellet.

6. A charge according to claim 4 in which at least one of said terminal portions of the wire has a generally circular configuration.

7. A charge according to any one of the preceding claims in which the density of a portion of the pellet contiguous with the conductor is less than the density of other portions remote therefrom.

8. An explosive charge substantially as hereinbefore described with reference to the accompanying drawings.

J. W. RANDALL,
Chartered Patent Agent,
P.O. Box 88,
160, Belgrave Road,
Leicester, LE4 5BX.

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1 SHEET This drawing is a reproduction of the Original on a reduced scale

Fig.1

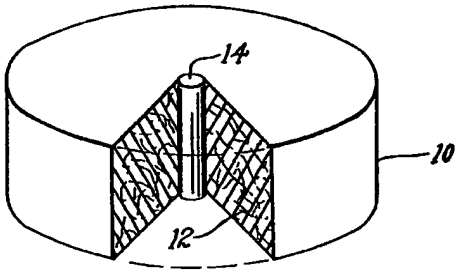

Fig.2

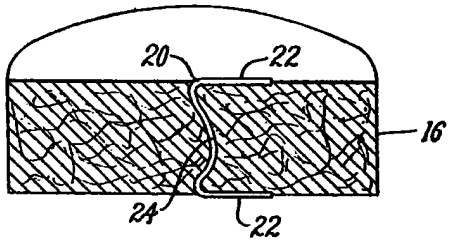

Fig.3

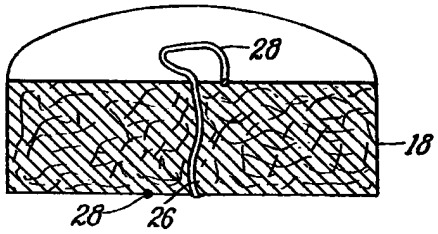

Fig.4